CHAPTER 4 OPERATIONAL PROCEDURES

"An airplane stands for freedom, for joy, for the power to understand, and to demonstrate understanding. Those things aren't destructible."

~ Richard Bach

4 Operational Procedures

The FAA continually enhances the procedures governing the operation of aircraft in the NAS. Procedural changes are implemented to increase airspace capacity, take advantage of improved aircraft and avionics performance, maximize the use of a new runway, or simply to make the existing air traffic management system work more efficiently.

Although less expensive and time-consuming than other capacity-enhancing solutions, such as building new runways, the development and implementation of new procedures is a complex process. The collaboration of the air traffic controllers and pilots who will be using the procedures is essential. In addition, both controllers and pilots must receive appropriate training before new procedures can be implemented.

Recent FAA actions to develop new operational procedures are discussed in this chapter. These procedures result in more efficient operations in the en route, arrival and departure, and approach phases of flight, and ultimately give pilots more flexibility in determining their route, altitude, speed, departure and landing times.

4.1 Spring/Summer 2003

In 2003 the FAA and airlines continued to work together to improve processes for managing traffic flow when convective weather disrupts flight schedules. This collaborative effort, referred to as the Spring/Summer plan, began in the year 2000, and the methods of maintaining smooth operations during severe weather have been gradually improved over the years. Two key improvements related to collaborative decision-making were implemented in 2003.

One improvement is a system that encourages airlines to give up a takeoff time in advance when an airport is experiencing delays. If another airline uses the returned slot for a flight that is already delayed 30 minutes or more, the airline that gave up the slot will receive a replacement slot that it can use for another delayed flight. This system, referred to as Slot Credit Substitution (SCS) encourages airlines to give up unneeded slots by compensating them for the loss of the slot. When the FAA knows in advance that an airline is canceling a flight and freeing up a slot, the FAA can recapture the slot, thus better utilizing that scarce resource. The system also gives airlines more flexibility in compensating for bad weather and keeping important connecting flights closer to schedule. Last year there were 1.2 million minutes of delay that could have been eliminated if all canceled slots had been used. In the first few weeks that the slot substitution process was available, it was used for rescheduling dozens of flights during severe weather. An initial analysis on the use of SCS between May and June 2003 showed that 4,032 minutes of delay were avoided, an average of 18 minutes of delay per aircraft.

Another improvement to the system for minimizing flight schedule disruptions due to storms is the implementation of the reroute advisory tool (RAT) graphic display. Previously, airlines had long lists of computer printouts to identify their affected flights; and flights that could have been rerouted often were not. The RAT standardizes the format for reroute advisories and provides a list of affected flights for each reroute. The flight list is provided to system users and FAA facilities to accurately depict what flights are included in a reroute. This allows system users and facilities common situational awareness for a reroute, and allows system users to participate in the pre-departure phase of the reroute process. The initial implementation of the RAT was for transcontinental reroutes that have at least one hour of lead time prior to commencement of the route, which allowed enough time for users to participate in the process of route planning, and was subsequently expanded to other routes. RAT usage leads to improved coordination of available reroutes, which minimizes the impact of severe weather and congestion.

4.2 Area Navigation Procedures

The accuracy of modern aviation navigation systems and user requests for increased operational efficiency in terms of direct routings have resulted in the development of Area Navigation (RNAV) procedures for the en route, terminal, and approach phases of aircraft operations. RNAV is a method of navigation that permits aircraft operation on any desired flight path, without reference to ground-based navigation aids. Aircraft equipped with a qualified Flight Management System (FMS), Global Positioning System (GPS), or Distance Measuring Equipment (DME). DME sensors can safely fly RNAV routes. RNAV operations provide a number of additional advantages over conventional navigation, including:

- ➢ Flexibility in permitting user-preferred routes that take advantage of optimal altitude and wind.
- ➢ Parallel routing to accommodate a greater flow of en route traffic.
- ➢ Establishment of bypass routes around high-density terminal areas and special use airspace.
- ➢ More efficient traffic patterns (i.e., between the en route, arrival, and final approach segments of the flight path).
- ➢ Fewer voice transmissions between the pilot and controller to execute approaches.
- ➢ Smoother and safer descent paths on approach.
- ➢ Approaches to more airports in low-visibility conditions.

The concept of Required Navigational Performance (RNP), which defines levels of RNAV accuracy, is explained below, followed by a discussion of the FAA's development of RNAV approach procedures. More information on the implementation of RNAV concepts to enhance airspace capacity en route and in the arrival and departure phases of flight is provided in Chapter 5.

4.2.1 Required Navigational Performance

Required navigational performance (RNP) defines RNAV accuracy requirements for a variety of operations. For example, terminal RNP operations are defined as RNP-1 meaning that the aircraft's navigation system must be able to maintain a total error of plus-or-minus one nautical mile 95 percent of the time. RNP specifies the performance requirements for the aircraft, but does not require that an aircraft be equipped with a specific navigation sensor. RNP concepts have been implemented within the airspace of several countries, as well as some areas of oceanic airspace (see Reduced Oceanic Horizontal Separation Minimum in this chapter).

In July 2003 the FAA published the "Roadmap for Performance Based Navigation," which describes the FAA's plan for evolving RNAV and RNP capabilities in the NAS through the year 2020. In the near term, the FAA will implement a first set of RNAV and RNP procedures for all phases of flight, and will develop criteria for more advanced RNAV and RNP operations. By 2005, the FAA will convert some RNAV routes to RNP-2 routes, and will initiate reduction of route spacing by 2006 where feasible. In addition, the FAA is planning the development of RNP departure procedures

(DPs) and standard terminal arrival routes (STARS), as well as RNP approaches to closely spaced parallel runways.

4.2.2 Area Navigation Approaches

Of the more than 3,000 commercial and general aviation airports in the United States, approximately 340 have a system such as an instrument landing system (ILS) to guide planes to the runway when visibility is poor. The FAA is increasing access to more airports in sub-optimal weather by pursuing an aggressive RNAV approach development schedule. RNAV approaches allow properly equipped airplanes to safely navigate landings in poor visibility to airports or runways that are not equipped with an ILS, or to a runway with an ILS that is out of service.

RNAV approaches can have three differing lines of minima. They are the LNAV (lateral navigation), LNAV/VNAV (lateral navigation/vertical navigation), and LPV (localizer performance with vertical guidance).

The LNAV minima is for a non-precision approach that can be conducted with approach-certified GPS or WAAS receivers. As of September 2003, the FAA had published more than 3,400 RNAV approaches with LNAV minima. The LNAV/VNAV minima falls between a conventional non-precision approach and a true precision approach. RNAV approaches with LNAV/VNAV minima have the lateral accuracy associated with non-precision approaches, but also have a stable, guided, vertical path similar to an ILS glideslope. RNAV approaches with LNAV/VNAV minima require the aircraft to be equipped with an approved barometric-VNAV system or a WAAS-certified receiver. The FAA has published more than 600 RNAV approaches with LNAV/VNAV minima at more than 200 airports.

The RNAV approach with LPV minima provides lateral guidance that is equivalent to or better than an ILS localizer, and vertical guidance that is only slightly less accurate than an ILS. An important benefit of LPV will be bringing vertically guided instrument procedures to several thousand runways that would normally not have a precision or ILS instrument approach, many which serve general aviation users. The use of LPV can provide near precision minima of 250 feet and 3/4-mile visibility at qualified airports.

The FAA has established a production plan schedule accessible to the public, which indicates the Agency's plan for publication of public Standard Instrument Approach Procedures (SIAP's). (See website: http://avn.faa.gov/index.asp?xml=nfpo/production) Initially the plan was created to establish a priority of RNAV production, but in the near future will include a production plan for all new public SIAP's. By 2010, all the U.S. Part 139 airports (those with commercial flights holding 30 or more passengers), and the other public airports with runways over 5,000 feet will have RNAV instrument approach procedures. Procedures for the remaining 1,300 public airports with paved runways (with runways less than 5,000 feet) will be completed after 2010.

The commissioning of WAAS in July 2003 made several hundred previously published RNAV approaches available to any properly-equipped user. While the initial benefits of WAAS will primarily apply to users of airports without an instrumented runway, WAAS offers benefits to the airlines and other users of the larger airports also. For example, airlines may benefit by WAAS opening additional runway ends to precision approach. While airlines primarily use airports equipped with an ILS, operations at smaller airports that feed into hubs will be made more reliable in adverse weather by the existence of RNAV approaches that can be flown by WAAS-equipped aircraft, making these feeder operations more immune to weather delays, and helping to keep hub operations on schedule. In addition, many airports have only a single precision ILS providing service to just one runway. WAAS will make non-ILS runways at the larger airports accessible in low visibility conditions.

Two manufacturers currently produce WAAS-certified receivers, and several others are working toward certification.

4.2.3 RNAV Arrivals and Departures

RNAV allows for the creation of arrival and departure routes that are independent of existing fixes and navigation aids, and provides multiple entries to existing Standard Terminal Arrival Routes (STARS) and multiple exits from Departure Procedures (DPs). Airports with multiple runways or with shared or congested departure fixes benefit the most from segregating departures and providing additional routings. Approximately 40 public-use RNAV's DPs have been implemented within the NAS. Many were commissioned by particular airlines and subsequently converted to public use. In 2004, the FAA will publish several RNP-2 and RNP-1 DPs and STARS where a high percentage of users are adequately equipped and the benefits are substantial, and 30 additional procedures annually in 2005 and 2006. The prioritization and time schedule for implementing these procedures has yet to be determined. Examples of recently implemented RNAV STARS and DPs are listed below:

- Four RNAV STARS and five RNAV DPs at Las Vegas allow efficient paths to and from the airport that are not dependent on the location of ground-based navigation aids. Preliminary results indicate that in at least one STAR, the flight distance was reduced by 25-30 nautical miles and in one DP the reduction was 15-20 nautical miles per flight.
- An RNAV DP at Boston's Logan Airport was implemented to reduce noise in environmentally sensitive areas.
- An RNAV DP at Newark improves access to departure gates due to reduced interaction with traffic from adjacent airports, and increases departure throughput.

4.3 Reduced Separation Minimum

Separation standards in a given airspace are determined by the communication, navigation, and surveillance capabilities available in the specific operating environment. As these capabilities improve due to technological advances, separation standards, also referred to as separation minimums, are being reduced incrementally in various regions of the world. Separation minimums have been already been reduced in large portions of airspace over land and the oceans, and the reduction of the vertical separation minimum for U.S. domestic airspace is expected by 2005.

4.3.1 Reduced Vertical Separation Minimum

Procedures implemented more than 40 years ago required a 2,000-foot minimum vertical separation between IFR aircraft operating above Flight Level (FL) 290, but only a 1,000-foot separation below FL290. The larger separation above FL290 was necessary because the altimetry used at that time had relatively poor accuracy at higher altitudes. The six flight levels available above FL290 became congested during peak travel periods. Over the past several years, the U.S. and other nations, in cooperation with the International Civil Aviation Organization (ICAO) and international air carriers, have reduced the vertical separation minimum from 2,000 feet to 1,000 feet in large portions of the world's airspace, increasing the number of available flight levels from 6 to 12.

In the RVSM environment, aircraft are more likely to receive their requested altitude and route, because more aircraft can be accommodated on the most time- and fuel-efficient tracks or routes available. RVSM also gives air traffic controllers greater flexibility in re-routing traffic around storms, and enabling aircraft to cross-intersecting flight paths above or below conflicting traffic. To ensure that aircraft will be able to maintain separation, aircraft that want to participate in RVSM must meet stringent altimetry system standards.

4.3.1.1 World-Wide Implementation of the Reduced Vertical Separation Minimum

RVSM has been implemented in oceanic airspace in the North and South Atlantic, the Pacific, the South China Sea, and in the portion of the West Atlantic Route System (WATRS) that is in the New York Oceanic Flight Information Region (FIR). RVSM has also been implemented in the continental airspace of Australia and Europe, and northern Canada. Canada is planning to implement RVSM in southern Canadian airspace at the same time that it is implemented domestically in the U.S.

4.3.2 U.S. Domestic Reduced Vertical Separation Minimum

The final rule on domestic RVSM implementation, published in October 2003, contains an implementation date of January 20, 2005. The new separation standards will apply to the 48 contiguous states, Alaska, and portions of the Gulf of Mexico, from FL 290-410 inclusive. With few exceptions, once DRVSM is implemented, aircraft that do not meet DRVSM equipage requirements will not be permitted between FL290 and FL410. Airplanes that are not yet RVSM-certified when DRVSM goes into effect will be handled at lower or higher altitudes. Approximately 38 percent of flights that operate in U.S. airspace above FL290 are already RVSM compliant. When implemented, DRVSM will help reduce en route delays and permit greater maneuverability in the vicinity of severe weather, and will eliminate the need for additional steps to transition aircraft from oceanic airspace, where RVSM is already in place, to domestic airspace.

4.3.3 Reduced Oceanic Horizontal Separation Minimums

Deficiencies in communications and surveillance capabilities over the ocean have required larger horizontal separation minimums for aircraft flying over the ocean out of radar range. But with the improved navigational capabilities made possible by technologies such as the global positioning system (GPS) and controller pilot data link communications, both lateral and longitudinal oceanic horizontal separation standards are being reduced.

Allowing properly equipped aircraft to operate at reduced oceanic separation will enable more aircraft to fly optimal routes, resulting in shorter flight times. Reduced separation laterally may provide space for additional routes, and reduced longitudinal (nose-to-tail) separation will provide more opportunity to add flights without a delay or speed penalty.

Oceanic lateral separation standards have been reduced from 100 to 50 nautical miles over much of the Pacific for aircraft that are RNP-10 approved. By 2005, it is expected that oceanic lateral and longitudinal separation minimums will be reduced to 30 nautical miles in portions of the South Pacific, extending to the entire Pacific in future years. Because flights along the South Pacific routes are frequently in excess of 15 hours, the fuel and time-savings resulting from more aircraft flying closer to the ideal wind route in this region are expected to be substantial. These reduced separation minimums will only apply to aircraft with sufficiently accurate navigation equipment (RNP-4), controller to pilot data link communication, and enhanced surveillance capabilities provided by automatic dependent surveillance.

4.4 Approaches to Closely-Spaced Parallel Runways

At airports with closely-spaced parallel runways, capacity is constrained in low-visibility conditions. When visibility is good pilots can conduct simultaneous visual approaches to closely-spaced parallel runways. But during periods of low visibility, simultaneous approaches to closely-spaced parallel runways monitored by conventional airport surveillance radar are not permitted. For parallel runways separated by 2,500 feet to 4,300 feet, two arrival streams can be maintained but operations are limited to parallel dependent instrument approaches using 1.5 mile staggered separation. For parallel runways spaced less than 2,500 feet apart, operations are restricted to one arrival stream, which effectively reduces the airport's arrival capacity to one-half of its capacity in visual meteorological conditions. To help reduce the negative effect of weather on arrival capacity, the FAA has developed several approach procedures that take advantage of the enhanced surveillance capability of the precision runway monitor (PRM). In addition, the FAA is developing RNP approaches to closely-spaced parallel runways that do not require the use of a PRM.

4.4.1 Approaches Using a Precision Runway Monitor

The PRM is a surveillance radar with enhanced range and azimuth accuracy that updates essential aircraft target information every one second, compared to a 4.8 second update rate for conventional radar. PRM also predicts the aircraft track and provides aural and visual alarms when an aircraft is within ten seconds of penetrating the non-transgression zone. During PRM approaches to closely-spaced parallel runways, a separate controller monitors each runway. Use of the PRM allows air traffic controllers to ensure safe separation of aircraft on the parallel approach courses and maintain an efficient rate of aircraft landings during adverse weather conditions. All pilots must complete special training before they are authorized to conduct a simultaneous ILS PRM approach to closely-spaced parallel runways.

The FAA has commissioned PRMs at Minneapolis, St. Louis, and Philadelphia International Airports. The PRM system at St. Louis is currently use to monitor Localizer Directional Aid (LDA) approaches to parallel runways spaced at 1,300-feet. PRMs are scheduled for commissioning at San Francisco and John F. Kennedy in early 2004, Cleveland in early 2005, and Atlanta in 2006, coincident with the completion of the fifth parallel runway. The FAA has approved the following procedures using a PRM to allow simultaneous instrument approaches in adverse weather.

- Simultaneous instrument approaches for 4,300 feet – 3,400 feet spacing (applicable to Minneapolis).
- Simultaneous instrument approaches down to 3,000 feet spacing with one instrument landing system (ILS) localizer offset by 2.5 – 3 degrees (Philadelphia and proposed for JFK).
- Simultaneous offset instrument approaches (SOIA) for parallel runways spaced at least 750 feet apart, and less than 3,000 feet apart at airports identified by the FAA (proposed for SFO).

Philadelphia began using its PRM for simultaneous approaches to parallel runways spaced 3,000 feet apart in June 2002. Currently, these approaches are permitted only in visual meteorological conditions. In the next phase of operations, scheduled for late 2003, the minimum weather requirements will be reduced as pilots and controllers gain experience with the procedure. The SOIA procedure would allow simultaneous approaches to parallel runways spaced from 750 feet to 3,000 feet apart. It requires the use of a PRM, a straight-in ILS approach to one runway, and an offset localizer directional aid (LDA) with glide slope approach to the other runway. At San Francisco International Airport (SFO) the arrival rate is 60 aircraft per hour in clear weather using both parallel runways, which are 750 feet apart. In times of heavy fog and low-ceiling conditions, aircraft are placed in-trail to one runway, reducing the airport arrival rate by half. The SOIA procedure will enable SFO to maintain an arrival rate of up to 40 aircraft per hour with a cloud base as low as 1,600 feet and four miles visibility. The FAA has completed flyability, collision risk, and preliminary wake turbulence analyses for the SOIA procedure at SFO, but the PRM has not yet been commissioned.

4.4.2 RNP Approaches to Closely Spaced Parallel Runways

The FAA is planning to take advantage of RNAV/RNP capabilities in the terminal area by developing RNP approaches to closely spaced parallel runways called RNP Parallel Approach Transitions (RPAT). RPAT procedures will improve access to airports with parallel runways separated by 4,300 feet or less in marginal visual meteorological conditions (VMC) when the airport acceptance rate is reduced due to discontinued use of simultaneous independent parallel approaches. The RPAT procedure would not require use of a PRM. The FAA plans to implement RPAT at three airports in 2004 and four in 2005. Figure 4-1 shows the initial seven airports and the potential arrival rate increase during marginal weather. Marginal VMC conditions occur from 5 to 20 percent of the time at these airports.

Figure 4-1 Potential Arrival Rates

Airport	Potential Arrival Rate Increase (Aircraft/Hour)
Boston Logan International (BOS)	24
Cleveland Hopkins International ((CLE)	10
Newark Liberty International (EWR)	21
Portland International (PDX)	20
Philadelphia International (PHL)	12
Seattle-Tacoma International (SEA)	14
San Francisco International (SFO)	20

Source: Roadmap for Performance-Based Navigation, July 2003.